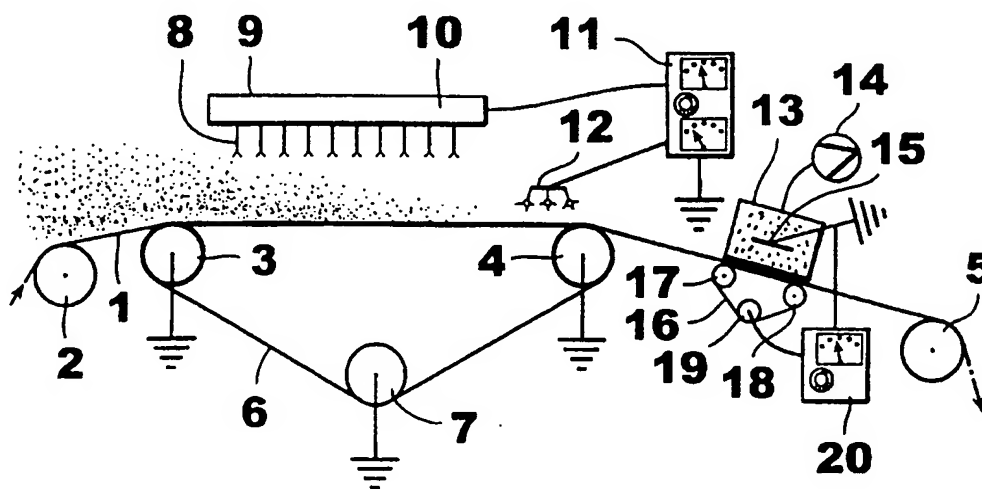




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<p>(21) International Application Number: PCT/FI98/00748</p> <p>(22) International Filing Date: 23 September 1998 (23.09.98)</p> <p>(30) Priority Data: 973776 24 September 1997 (24.09.97) FI</p> <p>(71) Applicant (for all designated States except US): VALMET CORPORATION [FI/FI]; Panuntie 6, FIN-00620 Helsinki (FI).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): NISSINEN, Vilho [FI/FI]; Onkimaantie 195, FIN-04660 Numminen (FI).</p> <p>(74) Agents: LAINE, Seppo et al.; Seppo Laine Oy, Itämerenkatu 3 B, FIN-00180 Helsinki (FI).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published</p> <p><i>With international search report.</i></p> <p><i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> <p><i>In English translation (filed in Finnish).</i></p>

(54) Title: **METHOD AND ASSEMBLY FOR CONTROLLING MIST AND DUST IN THE MANUFACTURE AND FINISHING OF PAPER AND BOARD**



(57) Abstract

The present invention relates to a method and assembly for controlling the behaviour of particulate matter such as mist and dust occurring in the manufacture of paper and board. In the method, a web (1) is passed to web treatment equipment (22, 23) wherein at least one treatment step is applied to the web (1) causing the emission of said particulate matter (24). According to the method, in the vicinity of the emission point (21) of said particulate matter, are placed at least two electrodes (25, 26), and at least one electrode, called a counter-electrode (26), is taken to a low potential. Further, at least one electrode (25) is taken to a potential higher than that of said counter-electrode (26), and the potential difference between said electrodes (25, 26) is made so high as to generate a corona discharge between said electrodes that causes an ion-blast wind toward the electrode (26) of the lower potential, said ion-blast wind being capable of transferring particulate matter, which enters the gap between said electrodes, toward said electrode of lower potential.

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**Method and assembly for controlling mist and dust in the
manufacture and finishing of paper and board**

5 The present invention relates to a method according to
the preamble of claim 1 for collecting water vapour,
escaped fibrous matter, coat mist and dry fibrous dust
occurring in the manufacture of paper and board or
adhering the same to the web being processed.

10

The invention also concerns an assembly for implementing
said method.

15 The manufacture of paper and board can be divided into
two phases comprising the formation of the base web, that
is, the base board or paper, followed by the treatment of
this web by coating, calendering, slitting and rolling.
With the exception of rolling, all of these steps involve
emission of different kinds of mist and dust that are
20 detrimental if allowed to escape to the surroundings.
Hence, a major portion of the paper machine and finishing
equipment must be enclosed in hoods and enclosures. From
the interior of such enclosed spaces, the mists are
removed by suction with a vacuum. The air sucked off from
25 the enclosed spaces is cleaned from moisture, dust and
mist prior to discharging the air into the ambient atmo-
sphere. Such enclosures as well as the cleaning of the
sucked air are expensive to implement. The collection
systems must be designed for large volumetric air flows,
30 because the internal surfaces of the hoods and equipment
must be kept free from condensation or dirt that could
fall or otherwise land on the web being manufactured.

Particularly in coating a paper web, water droplets or other foreign matter falling on the web can easily cause defects in the web being made. However, regions of insufficient flow velocity may remain in the hood structures that thus may allow accumulation of foreign matter in the system. Furthermore, the collection of coating mist in particular from the exhaust air is cumbersome and complex to arrange, because the collected waste coat cannot be dumped in the plant sewer system due to economical and environmental reasons, but rather, it is recirculated back to the machine circulation. However, as the coat returned to the machine circulation must be free from foreign matter and air bubbles, the collection of coat mist from an air flow is a technically challenging task.

It is an object of the present invention to provide a method suited for controlling the emissions of dusts, mists and other matter occurring in droplet or particle form in paper manufacture by virtue of guiding such matter to desired surfaces.

The goal of the invention is achieved by way of guiding the droplets or particles to be treated to impinge on a desired surface by means of both an electric field imposed between a counter-electrode taken to a low potential, advantageously to the ground potential, and a plurality of electrodes, advantageously having a pointed structures which are taken to an elevated potential, and additionally by the ion-blast wind induced by a corona discharge generated in the vicinity of the electrodes taken to the elevated potential. Such a collecting sur-

face may be formed by, e.g., the web being made or, alternatively, a purpose-made ground-potential electrode.

More specifically, the method according to the invention
5 is characterized by what is stated in the characterizing part of claim 1.

Furthermore, the assembly according to the invention is characterized by what is stated in the characterizing
10 part of claim 8.

The invention offers significant benefits.

By virtue of the invention, air-borne foreign matter can
15 be collected directly to a desired surface which may be a web being treated or formed, for instance. In the case that the coat dust, or alternatively, the humid and fiber-containing mist emitted from the web being formed can be effectively returned to the web running in the
20 process, the amount of foreign material to be removed by means of a vacuum will be reduced substantially and the cleaning of the exhaust air becomes easier. The mist emitted from the coating equipment can be collected directly to a counter-electrode (ground electrode), whereby
25 the collection and removal of coating mist takes place in a single step. Since the mist adheres under electric forces to the collecting electrode, the coating mix layer thus formed contains less air than waste coating collected by conventional techniques from an air flow making the
30 collected coat easier to return to the machine circulation. The design of the assembly is readily modifiable which is a great benefit as the installation space avail-

able in paper machines is extremely limited due to different reasons. By virtue of the assembly according to the invention, the emissions to be collected can be captured very close to their point of origin that helps to
5 prevent the soiling of the paper-making equipment. A particularly advantageous benefit is the possibility of returning the collected material back to the web, whereby the amount of recirculating material is reduced.

10 In the following, the invention will be examined in greater detail by making reference to the appended drawings, in which

Figure 1 shows schematically an embodiment of the invention;
15 and

Figure 2 shows schematically an embodiment of the invention.

20 The function of the present invention is based on an application of the so-called ion-blast technique. In this method, a strong electric field is established between one or generally a number of pointed discharge electrodes and a planar counter-electrode. The tip of the pointed
25 electrode supports a corona discharge that charges particles in the vicinity of the electrode and causes formation of ions in the electronegative gas. The ions migrate along the flux lines of the electric field formed between the discharge electrode and the ground-potential counter-electrode, whereby the ions adhere to particles on which
30 they impinge on their travel. The electric field transports particles thus charged to the ground-potential

electrode on which they adhere by electric and mechanical forces. If the spacing between the electrodes is made long and the voltage sufficiently high (greater than 50 kV), a gas flow will be created capable of mechanically transferring toward the ground-potential electrode the particles which are passing between the electrodes. This phenomenon is called the ion-blast wind. In the ion-blast effect, the electric field formed from the tip of a pointed electrode will create at the electrode tip a conical field in which the ionized gas and particles are transported. The ion-blast effect will affect both solid particles and liquid droplets.

In paper-making, the ion-blast effect can be utilized for binding a raw material to a web formation substrate or a collecting platform from which the collected material can be removed using a suitable technique. In practice, the collecting substrate may be formed by any surface which is transparent to the electric field or, alternatively, is a conductive surface. As the web in a continuous process is formed on a moving surface, the formation substrate is generally a wire, felt or band. When the method is employed for collecting material at a coating station, for instance, a counter-electrode may be used as the collecting substrate.

In Fig. 1 are shown different applications of the invention. The first embodiment illustrated in the diagram is particularly suited for adhering dust or coat mist to a web. Herein, a web 1 travels supported by four guide rolls 2 - 5. The first guide roll 2 and the last guide roll 5 only serve to support the incoming and outgoing

web 1, respectively. Over guide rolls 3, 4, which are adapted between the outer guide rolls 2, 5, is passed a conductive wire 6 which is arranged to travel along a closed triangular path so as to run over said web-supporting rolls 3, 4 and a wire guide roll 7 which is mounted at a distance from the web 1 itself. The rolls 3, 4, 7 guiding the conductive wire 6 are taken to the ground potential thus allowing said conductive wire 6 to provide a ground-potential surface under the web 1 running on said wire. On the opposite side of the web 1 in regard to the conductive wire 6, there are arranged pointed electrode tips 8 which are taken to an elevated potential and are mounted on an electrode support frame 10. The electrode support frame 10 is connected to a high-voltage supply 11. Next to the electrode tips 8 on the machine-direction travel of the web 1 is mounted a post-corona device 12 that is also connected to the high-voltage supply 12.

Further next on the travel of the web 1 is adapted a post-collector unit 13 serving to remove from the web 1 the dust just transferred to said web. The post-collector unit 13 comprises an enclosure housing a counter-electrode 15, whereby said enclosure is taken by means of a fan 14 to a vacuum and has its open side adapted to face the web 1. As the function of the post-collector unit 13 is to remove the dust adhering to the web 1, the counter-electrode 15 in the enclosure above the web is now taken to a low-voltage or ground potential. To the opposite side of the web 1 there is placed a conductive wire 16 running over a triangular path on guide rolls 17, 18, 19. With the help of a high-voltage supply 20, this

conductive wire 16 is now taken to a higher potential than the counter-electrode 15 in the post-collector device enclosure. Obviously, the running wire can be replaced by an endless belt or a band.

5

The field effect of the electrode tips 8 must extend over the desired area of collection. Since the electric field shed from each of the electrode tips 8 has a conical shape, the number and placement of the electrode tips must be arranged so that a uniform field is formed on the counter-electrode 6 by the resultant field of the conical component fields shed from the arrayed tips of discharge electrode tips. The required voltage depends on the distance of the counter-electrode 6 from the discharge electrode tips 8 that may vary from 2 mm to 2 m, while in practice a distance of 100 mm to 1000 mm must be used due to the space required by dust collection/transfer equipment. While a greater distance between the electrodes as such has no effect on the function of the apparatus, it will increase the size of the apparatus. The voltage applied between the electrodes may be varied in the range of 30 - 1000 kV, however, typically a voltage range of 80 - 160 kV has been found practical for the above-mentioned electrode arrangement. The counter-electrode may be taken to a positive or negative potential and, respectively, also the electrode tips can be connected to the positive or negative polarity of the voltage supply.

30

In the collection of dry dust, the above-described apparatus functions as follows. Web 1 is passed to the guide roll 2 from, e.g., a edge-trim slitte which during the trimming step releases dust from the edge of the web that

subsequently begins to travel along with the moving web 1 due to the boundary air layer carried by the web. When the web 1 comes under the discharge electrode tips 8, the ion-blast stream emitted from the electrode tips 8 carries the dust particles toward the conductive wire 6 which supports the travel of the web 1. The dust particles will adhere to the web 1 under electric and mechanical forces. Followingly, the dust particles will continue to travel on the web 1, thence being prevented from being scattered about. As a permanent adhesion of the dry dust to the web is not generally desirable, the dust is subsequently removed from the web. The dust-removal step is carried out by means of a post-collector device 13. In this apparatus, the electrode potentials are reversed in regard to those used in the above-described dust-adhering apparatus, whereby also the charge of the dust particles is reversed allowing them to leave the web 1. Next, the released dust migrates toward the counter-electrode 15 of the post-collector device 13 and further away from the post-collector device along with the suction flow established by the suction fan 14. The collected dust may be recirculated to the web formation process or, for instance, combusted to produce thermal energy.

In addition to the collection of dry dust, the method according to the invention may be employed to bind back to the web 1 either the fiber-containing water mist emitted from the web formation process, or, particularly, the coat mist emitted from the coating equipment, or, particularly, a specifically generated coat aerosol that is applied to the web at least partially by virtue of the ion-blast technique. Such a coat aerosol can be made with the

help of spray nozzles, for instance. Herein, the post-collector device 13 will obviously be omitted, because the particles are desiredly adhered to the web in a permanent manner. The ion-blast assembly may under certain
5 conditions act as a capacitor capable of storing a charge, whereby the forces that hold the web against its carrier can act disturbingly after the web has passed the counter-electrode area. In order to neutralize such forces of attraction, a corona treatment operating with
10 positive or negative ions may be employed downstream from the web formation unit. The corona treatment is carried out using a device 12 with a structure similar to that of the ion-blast assembly.

15 In Fig. 2 is shown schematically a collection method for mist emitted from the nip 21 of a transfer-roll coater. As the structure of the transfer-roll coater is irrelevant to the application of the invention, the coater is illustrated only for the nip 21 formed between two rolls
20 22, 23. The lower roll is a transfer roll 22 from whose surface the metered coat is transferred in the nip 21 to the surface of the web 1 passing through the nip. The function of the backing roll 23 is to maintain a proper distance between the web 1 and the transfer roll 22.
25 Particularly at high web speeds, a great amount of mist 24 will be emitted from the nip of a transfer-roll coater due to the interaction of the web 1 and the applicator roll. The mist is formed when a portion of the coat film carried on the surface of the transfer roll 22 adheres to
30 the web 1 and the other portion continues to adhere to the surface of the transfer roll 22, whereby the coat film undergoes splitting when the web 1 exits from the

nip 21 and thereby some amount of coat droplets are ejected from the nip tangentially with the surface of the web 1 and the surface of the transfer roll 22.

- 5 According to the invention, the thus emitted mist can be collected with the help of the ion-blast effect on a counter-electrode 26. The electrodes 25 and 26 are mounted, e.g., as shown in Fig. 2 in the angle formed between the transfer roll 22 and the web 1 so that the
- 10 pointed electrodes 25 can be used to ionize the mist emitted into the gap between the electrodes, thus transporting the mist to the counter-electrode 22, wherefrom it can be collected for reuse. Accordingly, the electrodes are arranged so that the emitted mist will be
- 15 enclosed by the electrodes. While the coating mist falls naturally downward along the counter-electrode surface gravitationally, its removal may be augmented by vibration or scraping.
- 20 Obviously, the above-described examples and the different embodiments covered by their specifications in the appended claims may be implemented using one or a greater number of power supplies.

Claims:

1. A method of controlling of particulate matter such as mist and dust in the manufacture of paper and board, in which method a web (1) is passed to web treatment equipment (22, 23) wherein at least one treatment step is applied to the web (1) causing the emission of the particulate matter (24),
- characterized by
- placing in the vicinity of a emission point (21) of said particulate matter at least two electrodes (25, 26),
 - connecting at least one electrode, - a counter-electrode (26) -, to a low potential,
 - connecting at least one electrode (25) to a potential higher than that of said counter-electrode (26), and
 - making the potential difference between said electrodes (25, 26) so high as to generate a corona discharge between said electrodes that causes an ion-blast wind toward the electrode (26) of the lower potential, said ion-blast wind being capable of transferring particulate matter, which enters the gap between said electrodes, toward said electrode of lower potential.

2. A method as defined in claim 1, c h a r a c t e r -
i z e d by

5 - implementing said counter-electrode bu using an
 endlessly movable, electrically-conducting
 support member (6),

 - mounting said conducting support member (6) to
10 rest against said moving web (1), and

 - adapting on the opposite side of the web (1) in
 regard to said support member (6) a plurality of
 pointed discharge electrodes (8) that are taken
15 to a potential higher than that of said counter-
 electrode (6), whereby

 particulate matter, which enters the gap between said
 pointed electrodes (8) and said web (1), will migrate to
20 said web (1) so as to adhere to the same under electric
 and mechanical forces.

3. A method as defined in claim 1, c h a r a c t e r -
i z e d by

25 - implementing said electrode connected to a
 higher potential by using an endlessly movable,
 electrically-conducting support member (16),

 - mounting said conducting support member (16) to
30 rest against said moving web (1), and

- adapting on the opposite side of the web (1) in regard to said support member (16) at least one counter-electrode (15) that is taken to a potential lower than that of said moving support member (6), whereby

particles adhered to said web (1) are detached from said web and migrate toward said counter-electrode (15).

4. A method as defined in claim 1, in which method coat is applied to the surface of a web (1) by means of an applicator device, characterized by arranging electrodes (26, 25) in the vicinity of the mist formation area to bring the emitted mist into the gap between said electrodes, wherefrom the mist is transferred by the ion-blast effect to the counter-electrode.

5. A method as defined in any of foregoing claims, characterized in that the potential difference between the electrodes is selected to be in the range of 30 - 1000 kV, advantageously 80 - 160 kV.

6. A method as defined in claim 5, characterized in that the distance between the electrodes of different potentials is set to be in the range of 2 mm - 2 m, advantageously 100 - 1000 mm.

7. A method as defined in claim 2, characterized by using treatment equipment of the web (1) for forming coat mist which is at least partially transferred

to the web and adhered thereto by means of ion-blast techniques.

8. An assembly for controlling particulate matter such
5 as mist and dust in the manufacture of paper and board,
said assembly comprising means for passing a web (1) to
web treatment equipment (22, 23) wherein at least one
treatment step is applied to the web (1) causing the
emission of said particulate matter (24),

10

c h a r a c t e r i z e d b y

- at least two electrodes (6, 8) placed in the
vicinity of the emission point of said particu-
15 late matter,

- at least one power supply (11) capable of
taking at least one electrode, - a counter-
electrode (6) -, to a low potential and further
20 taking at least one electrode (8) to a potential
higher than that of said counter-electrode (6) in
a manner that makes the potential difference
between said electrodes (6, 8) so high as to
generate a corona discharge between said elec-
25 trodes that causes an ion-blast wind toward the
electrode (6) of the lower potential, said ion-
blast wind being capable of transferring particu-
late matter, which enters the gap between said
electrodes, toward said electrode of lower
30 potential.

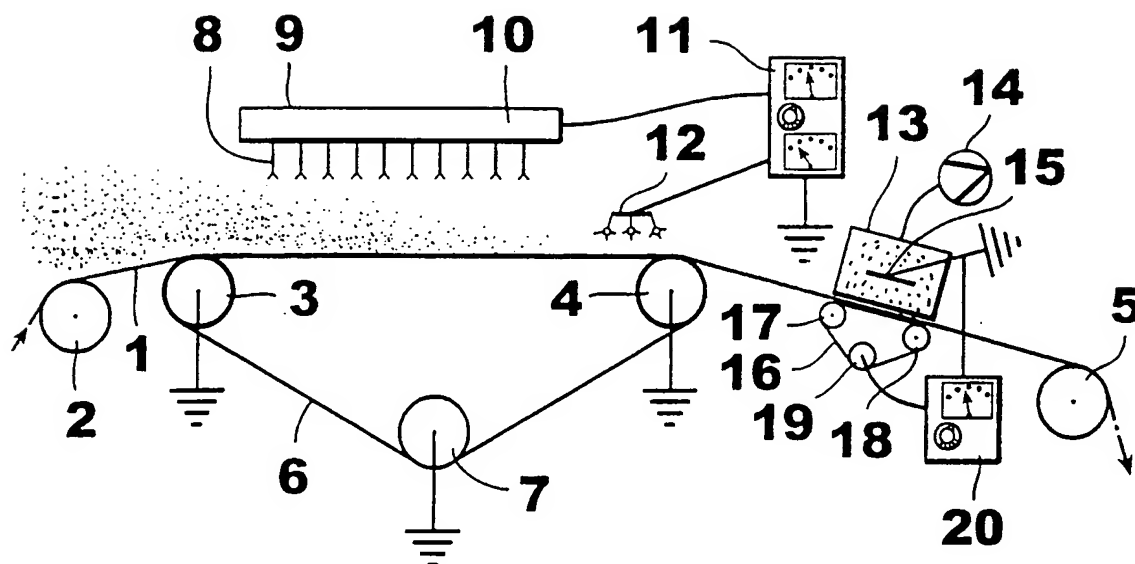
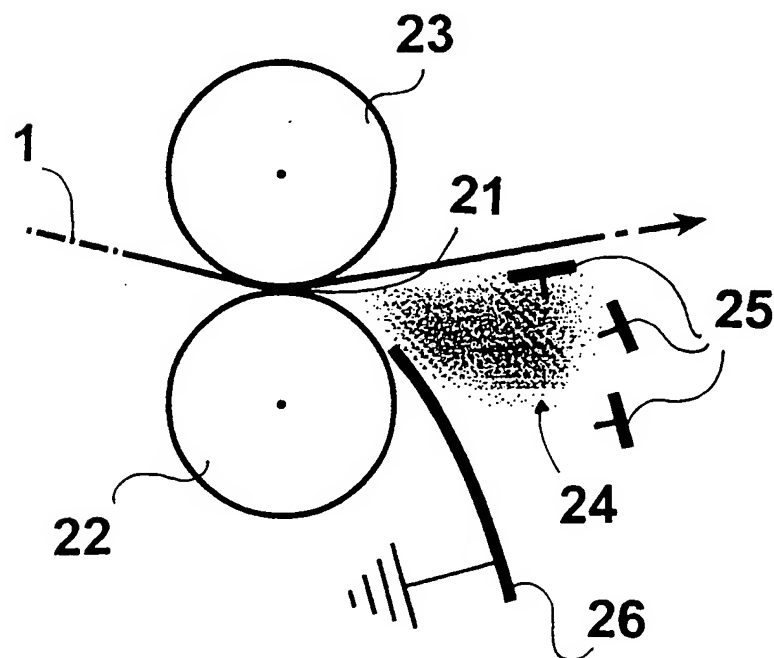
9. An assembly as defined in claim 8, c h a r a c -
t e r i z e d in that said counter-electrode is an
endless support member (6) mounted so as to travel
synchronously at least partially backing said moving web
5 (1) and that said electrodes taken to the higher
potential are pointed electrodes (8).

10. An assembly as defined in claim 8, c h a r a c -
t e r i z e d in that said electrode taken to the higher
10 potential is an endless, electrically-conducting support
member (6) mounted so as to travel synchronously at least
partially backing said moving web (1) and that said
counter-electrode is adapted into an enclosure taken to a
vacuum and having its open side adapted to face the oppo-
15 site side of the web (1) in regard to said support member
(6).

11. An assembly as defined in claim 8, in which assembly
the treatment equipment of the web (1) is a coat applica-
20 tor device, particularly a transfer-roll coater (22, 23),
c h a r a c t e r i z e d in that said electrodes
(25, 26) are adapted in the angle formed between the web
(1) exiting said coater (22, 23) and said coat applicator
device (22) so as to bring the mist emitted from said
25 applicator device into the gap between the electrodes,
wherefrom it is transferred by virtue of the ion-blast
effect to the electrode of the lower potential.

12. Use of ion-blast techniques in the coating of a
30 paper or board web for the purpose of transferring coat
particles to said web (1) and assuring the adherence of
coat to said web (1).

1/1

**Fig. 1****Fig. 2**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 98/00748

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21G 9/00, B05D 1/04, D21H 23/78, B03C 3/017

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D21G, D21F, D21H, B05D, B05B, B08B, B03C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 98/00748

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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